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General Assembly will review water reuse rules

by Jeri Gray

Advocates of water reuse (use of municipal reclaimed water) who are unhappy with reuse rule changes adopted by the N.C. Environmental Management Commission in November 2010 have sent the required number of letters to the N.C. General Assembly to have lawmakers review the rules.

According to Don Safrit, chairman of the Water Reuse Committee of the N.C. American Water Works Association-Water Environment Association (N.C. AWWA-WEA), legislation blocking two of the EMC rules (15A NCAC 02U.0113 Permitting by regulation and 15A NCAC 02U.0501 Reclaimed water utilization) is expected to be introduced within days. The requirement for legislative review will delay the effective date for the entire rule package.

Water reuse is State policy

In 2008, the N.C. General Assembly declared that "It is the public policy of the State that the reuse of treated wastewater or reclaimed water is critical to meeting the existing and future water supply needs of the State." The legislature directed the N.C. Environmental Management Commission to adopt rules to identify new reuse uses, facilitate the permitting of new reclaimed water systems, and establish standards to prevent direct distribution of reclaimed water as potable water.

At that time, changes to the rules governing reuse were already under development at the insistence of organizations and municipalities backing expanded use and relaxed regulation of reclaimed water.

After two years of rule development, public comment, and negotiation, final rules were adopted by the EMC last November. The EMC Hearing Officers report on rule development contends that the rule changes "represent a reasonable balance between increased flexibility for generators and users of reclaimed water and appropriate regulatory requirements needed to assure the safe use of reclaimed water."

However, Safrit said that reuse advocates believe the rules perpetuate a bureaucratic stranglehold that discourages water reuse in North Carolina and thereby impedes access to a valuable asset that can help conserve the state's water resources.

It now appears that the General Assembly will decide which view will guide the regulatory approach to implementing State policy.

Reuse background: inauspicious origin

Water reuse evolved from land application of wastewater. Land application was a direct result of the goal stated by the federal Water Pollution Control Act Amendments of 1972 (Clean Water Act) that "the discharge of pollutants into navigable waters be eliminated by 1985." The law required that wastewater treatment plants consider all viable alternatives to stream discharge of wastewater effluent.

Land application has long been considered an effective alternative for

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treating and disposing of wastewater effluent, but, as wastewater disposal, it has historically been tightly regulated in North Carolina, with very limited uses, requirements for large buffer areas to prevent runoff into streams, and prohibition of use where the public could have access to the treatment area. North Carolina regulations governing land application were, prior to adoption of the 2010 rule changes, contained in a chapter called "Waste not discharged to surface waters." (15A NCAC 02T). The "02T" rules have extensive requirements for site characterization, loading rates of various parameters, buffers and setbacks, monitoring and reporting.

Drivers of water reuse

As federal requirements for wastewater treatment became more stringent beginning in the 1970s, the cost of treating wastewater rose dramatically, and wastewater effluent quality at some publicly owned treatment works (POTWs) began approaching drinking water quality. Municipalities in the arid Southwest had been using reclaimed wastewater to augment water supplies for decades. However, in the 1970s and 1980s municipalities in urban areas across the county began to realize that the high quality effluent they were producing was a potentially valuable resource, and that by reusing it rather than discharging it they could cut disposal costs and gain additional water supply more economically than by developing new resources.

While the federal government does not regulate water reuse, in 1980 the U.S. EPA published guidelines for reuse to help states develop their own programs in response to increasing municipal interest. In a 1992 WRRI report, Watts described significant reuse programs in Arizona, Colorado, California, Texas, Georgia and Florida. That same year, the Triangle J. Council of Governments issued a study of the technical and economic feasibility of nonpotable reuse by six municipal systems in the region. By the time EPA published the 2004 update to its reuse guidelines, the majority of states had adopted regulations or guidelines.

A modification of N.C. regulatory approach

Into the 1990s North Carolina considered use of reclaimed municipal wastewater as wastewater disposal and permitted it as such. Changes to the "waste not discharged to surface waters" rules adopted in 1996 signaled the beginning of a change in regulatory approach by expanding reuse in North Carolina from just golf course irrigation to many other uses listed in the EPA guidelines and allowed by other states throughout the country. In 2006, North Carolina introduced the concept of "beneficial reuse" for the purpose of water conservation and the terms "conjunctive" to denote beneficial reuse and "nonconjunctive" to denote waste disposal. However, many of the requirements for land disposal of wastewater continued to be applied to the primary use for reclaimed water—irrigation—which reuse advocates consider unnecessary given the high quality of the reclaimed water.

Concerns about reuse

As the regulatory approach began to change, differences in perspectives on water reuse between reuse advocates on the one hand and regulators and public health/environmental groups on the other hand came into focus.

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A major concern of the public health/environmental advocates was the potential risk to public health from irrigation of public areas with reclaimed water. A study conducted at a golf course receiving reclaimed water from the Charlotte-Mecklenburg Utilities District's water reclamation facility and reported in 2003 by Hilger and Sobsey found that "viral contaminants may persist even where bacterial indicators are not found," and recommended that regulators perform continuous assessment of the "types and amount of indicator organisms allowable." Monitoring requirements for indicator organisms is still a point of contention between regulators and municipalities.

Among the many concerns expressed by environmental groups is that reclaimed water that has not gone through a nutrient removal process could contribute nutrients to surface waters through runoff. They advocate large buffers and other measures to prevent runoff from sites irrigated with reclaimed water.

In addition, even high quality reclaimed water contains various nutrients, micronutrients and salts that can affect soil properties, and, over time, perhaps groundwater. Nutrient build-up and soil salination are well-known effects of long-term irrigation or overloading with reclaimed water.

The expansion of uses for reclaimed water also raised questions about the potential effect of large reuse programs on streamflow. At an AWWA-WEA conference on reclaimed water in 1996, staff of the N.C. Division of Water Resources presented the results of an analysis of the effect of water reuse on streamflow. In the presentation "Strategic Management Implications of Water Reclamation and Reuse on Water Resources," the authors concluded:

If the reuse does not offset a potable water demand, in effect a new demand has been created that would not otherwise exist. The withdrawal, therefore, cannot be reduced and the streamflow below the discharge will be reduced as compared to a system without reuse. This could hurt aquatic habitat and limit downstream users. The potential effects of reduced discharges on minimum flow requirements could affect the availability of water for withdrawal and discharge. If reused wastewater does not offset an existing water demand, the more appropriate term to apply is wastewater disposal rather than water reuse.

Environmental groups contend that irrigation with reclaimed water during periods of water scarcity—one of the major benefits of reuse touted by advocates—will increase consumptive use and reduce return flow with particularly dramatic effects on aquatic life.

Continued pressure for rule revision

The continued perception and regulation of high quality reclaimed water as wastewater frustrated reuse advocates in North Carolina, and as allowed uses for reclaimed water expanded in the leading reuse states, groups including the N.C. AWWA-WEF, the N.C. League of Municipalities, and the N.C. Nursery and Landscape Association continued their campaign to expand uses here. They were aided by severe droughts in 1998-2002 and 2007-2008 that helped convince the N.C. General Assembly that reclaimed water is a valuable resource.

Rules adopted in November 2010 do expand allowable uses. Reclaimed water provided by a conjunctive system (essentially one that has NPDES permit for surface water discharge) can now be used to irrigate food chain crops. A conjunctive system can provide reclaimed water to irrigate single family residential lots and small commercial lots without having the sites individually permitted. Reclaimed water can also now be used for "augmentation" of pine and hardwood flat wetlands. And, reclaimed water can now be used for street washing. However, many of the uses are still subject to site assessments, loading rates, buffer and monitoring requirements and other permitting conditions that reuse advocates consider burdensome and unnecessary.

In addition, reclaimed water still cannot be used in North Carolina for a notable purpose that that EPA guidelines recommend, other states allow, and other cities increasingly practice: indirect potable reuse. Reclaimed water cannot be used in North Carolina for aquifer recharge or aquifer storage and recovery for drinking water purposes.

Several countries, including Australia, and at least five U.S. States (Florida, Arizona, California, Texas and Washington) allow groundwater recharge systems for augmenting drinking water sources. The same advances in membrane technology that have made desalination economically feasible have made it possible for reclamation systems to produce effluent of high enough purity for indirect potable reuse. In 2008 the Stockholm International Institute awarded the Orange County, California, Water District and Sanitary District its Stockholm Industry Water Award for "pioneering work to develop the world's largest water purification plant

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for groundwater recharge." The water is highly treated using reverse osmosis membranes and is used not only to recharge groundwater for potable water supply but also as a saltwater barrier.

Legislative review

Dealing with some of the permitting requirements that reuse advocates object to may be something legislators can do fairly expeditiously. However, allowing groundwater recharge and aquifer storage and recovery with reclaimed water in North Carolina would take more than simply changing EMC rules. State law prohibiting injection of waste into groundwater and public health rules would also have to be changed. If lawmakers choose to tackle indirect potable reuse, they will have their work cut out for them. However, according to Don Safrit, "We must decide once and for all if reclaimed water is a 'resource' or 'wastewater.'"

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Environment-related legislation introduced in the N.C. General Assembly

The 2010-2011 biennium of the N.C. General Assembly convened on January 26, 2011. The following environment-related legislation has been introduced:

HB 20. AN ACT TO APPROPRIATE FUNDS FOR MONITORING AND EMERGENCY CLEANUP OF THE TEXFI SITE CONTAMINATION. Appropriates $50,000 from the General Fund to the N.C. Division of Waste Management to cost share federal funds for the cleanup and monitoring of the Texfi site in Fayetteville. (Hazardous substances have been identified in the soil and groundwater at a former textile dyeing and finishing site adjacent to the Cape Fear River. Because the contamination has affected the Fayetteville Public Works water treatment plant property, it is a cleanup priority for the Division of Waste Management.) http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H20v1.pdf

HB 45 AN ACT TO ALLOW THE USE OF RISK-BASED REMEDIATION TO ACCELERATE THE CLEANUP OF CONTAMINATED INDUSTRIAL SITES FOR THE PURPOSE OF LIMITING HUMAN AND ENVIRONMENTAL EXPOSURE TO SAFE LEVELS, TO PROTECT CURRENT AND LIKELY FUTURE USES OF GROUNDWATER, AND TO ENSURE THE COST-EFFECTIVE APPLICATION OF LIMITED PUBLIC AND PRIVATE RESOURCES. Authorizes the Department of Environment and Natural Resources to approve site-specific standards applicable or relevant under federal remediation programs for the remediation of contaminated industrial sites covered by specific programs or statutes. Provides guidance for establishing standards. http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H45v1.pdf

HB 62 AN ACT TO PROHIBIT THE RULE TO CHANGE THE WATER QUALITY CLASSIFICATION OF BOYLSTON CREEK FROM BECOMING EFFECTIVE. http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H62v1.pdf

HB 116 AN ACT REGARDING THE DELINEATION OF PROTECTIVE RIPARIAN BUFFERS FOR COASTAL WETLANDS IN THE NEUSE RIVER AND TAR-PAMLICO RIVER BASINS. Provides that if State law requires a protective riparian buffer for coastal wetlands in either the Neuse River Basin or the Tar-Pamlico River Basin, the coastal wetlands and marshlands shall not be treated as part of the surface waters but instead shall be included in the measurement of the protective riparian buffer and sets out methods for delineating buffers. http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H116v1.pdf

HB 119 AN ACT TO AMEND CERTAIN ENVIRONMENTAL AND NATURAL RESOURCES LAWS TO (1) CLARIFY THE PROHIBITION ON DISPOSAL IN LANDFILLS OR BY INCINERATION OF BEVERAGE CONTAINERS THAT ARE REQUIRED TO BE RECYCLED BY CERTAIN ABC PERMITTEES; (2) DIRECT THE ENVIRONMENTAL MANAGEMENT COMMISSION AND THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES TO INCORPORATE STORMWATER CAPTURE AND REUSE STANDARDS AND BEST MANAGEMENT PRACTICES INTO STORMWATER RUNOFF RULES AND PROGRAMS; AND (3) AMEND THE WATERUSE STANDARD FOR PUBLIC MAJOR FACILITY CONSTRUCTION AND RENOVATION PROJECTS TO REQUIRE THE INSTALLATION OF WEATHER-BASED IRRIGATION CONTROLLERS AND AUDITS OF EXISTING IRRIGATION SYSTEMS BY A LICENSED IRRIGATION CONTRACTOR. http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H119v1.pdf

HB 135 AN ACT (1) TO REQUIRE THE NORTH CAROLINA UTILITIES COMMISSION TO ESTABLISH TIERED ELECTRICITY RATES FOR RESIDENTIAL, COMMERCIAL, PUBLIC, AND INDUSTRIAL CUSTOMERS TO ENCOURAGE ENERGYCONSERVATION AND ENERGY EFFICIENCY; (2) TO CREATE THE ENERGY EFFICIENCY PUBLIC BENEFIT LOAN FUND TO BE USED FOR LOANS TO CUSTOMERS FOR THE COSTS OF CERTAIN ENERGY EFFICIENCY OR RENEWABLE ENERGY PROJECTS; AND (3) TO CREATE AN INCENTIVE FOR CONSUMERS TO PURCHASE ENERGY STAR QUALIFIED HOUSEHOLD PRODUCTS. http://www.ncga.state.nc.us/Sessions/2011/Bills/House/PDF/H135v0.pdf

SB 22. AN ACT TO LIMIT NEW AGENCY REGULATORY REQUIREMENTS. Provides that an agency may not adopt a rule that results in additional costs on persons subject to the rule unless the rule is required by a serous and unforeseen threat to the public health, safety or welfare, an act of the General Assembly or the U.S. Congress, a change in federal or State budgetary policy, a federal regulation or a court order. (Includes some of the same provisions as Executive Order 70 issued by Governor Purdue in October 2010.) http://www.ncga.state.nc.us/Sessions/2011/Bills/Senate/PDF/S22v3.pdf

SB 75. AN ACT TO PROMOTE THE USE OF ELECTRICITY DEMAND REDUCTION TO SATISFY RENEWABLE ENERGY PORTFOLIO STANDARDS. Amends Section 62-133.8 of the General Statutes (Renewable Energy and Energy Efficiency Portfolio Standard) to add the definition of "Electricity demand reduction." The term is defined to mean "a measurable reduction in the electricity demand of a retail electric customer that is voluntary, under the real-time control of both the electric public utility and the retail electric customer, and measured in real time, using two-way communications devices that communicate on the basis of standards." http://www.ncga.state.nc.us/Sessions/2011/Bills/Senate/PDF/S75v1.pdf

Asheville responds to U.S. Department of Health and Human Services fluoride level proposal

In January the City of Asheville lowered the level of fluoride in its regional water system to 0.7 milligrams per liter (mg/L), the lowest end of the range currently recommended by the U.S. Department of Health and Human Services (DHHS). The action came in response to a proposal by DHHS to change the 1962 U.S. Public Health Service Drinking Water Standard for fluoride concentration from a range of 0.7 – 1.2 mg/L to 0.7 mg/L.

DHHS announced the recommendation on January 7, 2011, and published it in the Federal Register on January 13. The agency said it was proposing a new public health standard for fluoride because of new data on changes in the prevalence of dental fluorosis and the contribution of fluoride in drinking water to total fluoride exposure in the United States. Dental fluorosis is a change in the appearance of the tooth's enamel. These changes can vary from barely noticeable white spots in mild forms to staining and pitting in the more severe forms.

At the same time, the U.S. EPA announced that, as part of its current six-year review of national primary drinking water standards, it is initiating a review of the maximum amount of fluoride allowed in drinking water. Currently, under the Safe Drinking Water Act, EPA has an enforceable maximum contaminant level for fluoride of 4.0 mg/L set to protect against potential health problems (effects on the skeleton) and a non-enforceable maximum contaminant level goal of 2.0 mg/L aimed at preventing cosmetic or aesthetic effects.

At EPA's request, in 2006 the National Academy of Sciences reviewed new data on fluoride and issued a report recommending that EPA update its health and exposure assessments to take into account bone and dental effects and to consider all sources of fluoride. Information about the EPA review can be found at: http://water.epa.gov/drink/contaminants/basicinformation/fluoride.cfm

Fluoridation important for dental health

Federal and state public health agencies, the American Dental Association, and other groups stress the success of fluoridation in reducing the incidence of dental caries in children. The CDC names fluoridation as one of the ten great public health achievements of the 20th Century. However, because of the increasing presence of fluoride in many consumer products—including toothpaste, bottled water, soft drinks, fruit juices and some dietary supplements—and more individual consumption of these products, without careful monitoring of fluoride intake, young children can be exposed to excessive levels of fluoride and can develop fluorosis. Dental fluorosis occurs only when younger children consume too much fluoride when teeth are developing under the gums. The Center for Disease Control and Prevention has issued guidelines for parents for preventing excess exposure to fluoride: http://www.cdc.gov/fluoridation/safety/dental_fluorosis.htm#11

Local water systems decide whether to add fluoride to their drinking water, and according to the N.C. DHHS, 88 percent of North Carolinians who get drinking water from public systems receive drinking water fluoridated at a recommended concentration of 1 mg/L. CDC also provides information on fluoridation of drinking water by participating N.C. water systems: http://apps.nccd.cdc.gov/MWF/CountyDataV.asp?State=NC

Lawsuits proliferate over Florida numeric nutrient standards

In early December 2010, Florida's Attorney General and Agriculture Commissioner announced that the State of Florida had filed a lawsuit in U.S. District Court in Pensacola against the EPA over the agency's promulgation of numeric nutrient standards for Florida waters. The suit alleges that EPA's action was arbitrary, capricious, and an abuse of discretion. The suit says EPA relies on a methodology that is not scientifically sound and not site specific for Florida's waters. It asks the court to enjoin the EPA from implementing the numeric criteria for Florida.

Later that month, Okaloosa County, Destin Water Users, South Walton Utility Co., the Emerald Coast Utilities Authority and Panama City filed suit in federal court saying the EPA nutrient standards are not based on good science and would require extensive overhaul of treatment plants. Suits have also been brought by the Florida League of Cities and the Florida Stormwater Association, and the fertilizer and mining industries.

The suits followed fast on the heels of EPA's December 6, 2010, promulgation of a nationally watched regulation that was required by an August 2009 settlement of a suit brought by environmental groups to force the setting of numeric nutrient standards. Environmental groups in Wisconsin and Kansas have since brought suit to force EPA to promulgate numeric nutrient criteria for waters of those states. If the EPA rule withstands the onslaught of suits in Florida, the results could be far-reaching.

ECU scientists probe Tar River-groundwater interactions

How much a stream interacts with the groundwater system that underlies it strongly affects water chemistry of streams and has important implications for wellhead protection, bank filtration, stream ecology and the transport of nonpoint source pollution from adjacent lands. However, little work has been done to illuminate the nature of river-groundwater interactions along Coastal Plain streams. While many methods have evolved for studying the diverse surface water-groundwater interactions along active river channels, ground penetrating radar (GPR) has recently emerged as a potentially less time-consuming tool for investigation of the architecture of the sedimentary deposits that partly control the groundwater-surface water interactions. In a WRRI-sponsored project, investigators at East Carolina University have employed traditional methods and GPR to study river-groundwater interactions along the Tar River in Edgecome and Pitt counties. The project has advanced understanding of Tar River–groundwater interactions and Coastal Plain streams in general.

Methods

To determine long-term variations in baseflow contributions in the Tar River, investigators obtained daily discharge data from the USGS Tarboro gage for the period 1931-2002 and statistically analyzed the data to determine trends in discharge and discharge variability. They also obtained USGS stream flow records from Tarboro and Greenville to quantify seasonal downstream increases in stream flow. Using daily streamflow measurements, they performed hydrograph separation to distinguish between baseflow and stormflow components To determine large-scale groundwater inputs to the Tar River, they compared differences in baseflow between Tarboro and Greenville.

The investigators instrumented five sites along a 22 km reach of the Tar River extending from Falkland (13 km northwest of Greenville) to Rainbow Banks (Greenville) in order to characterize the interaction of ground water and surface water, They installed channel piezometers within the river channel at all sites and nested piezometers at four sites adjacent to the river at depths of 4 and 7 meters below the channel sediment-water interface. Using hydraulic conductivity values and river-groundwater head gradients measured in 18 piezometers, they calculated groundwater flux to and from the river channel.

They ran twenty-one GPR surveys to characterize heterogeneity in the underlying active river channel sediments and correlated sediment logs and hydraulic conductivity information from borings within and adjacent to the river channel with reference horizons in the GPR data.

Findings

The hydrograph separation of daily discharge data from 1931 to 2003 revealed that on average, baseflow made up sixty percent of total discharge in the Tar River and that there was strong seasonality in baseflow related to variations in rainfall and evapotranspiration. Data analysis showed that predictions of baseflow based on past statistical data would be most reliable for the non-growing season and least reliable for the hurricane season.

Analysis of long-term variation data showed a notable decline in average total discharge, baseflow, and runoff during the 1970s after which there was a slight decrease in average baseflow. Recent baseflow minimums are significantly lower than those observed before 1972. Data also indicate that streamflow and baseflow have become more variable over time along the Tar River. These changes may be related to intensification of the global hydrologic cycle, with trends of increased rainfalll, runoff and drought during the last century.

Along the study reach, baseflow typically increases downstream for most of the year. However, during the period 1997-2006 there were baseflow losses between Tarboro and Greenville on numerous occasions. The loses could be caused by downward seepage through channel sediments or by evapotranspiration.

Patterns in hydraulic conductivity and specific conductance related to channel asymmetry are evident. The south side of the river has steep banks and is underlain by sediments that have low hydraulic conductivities. On the north side, the floodplain is extensive and underlying sediments tend to be sandy deposits that are more permeable. A comparison of specific conductance of groundwater in the river channel and the hydraulic conductivity of river channel sediments shows an inverse relationship, which may be a useful tracer of river-groundwater interactions in this and other Coastal Plain streams.

GPR surveys at the Falkland section of the study reach indicate an erosional base of the river channel, about 3 to 3.5 meters below the river level, that is likely to be the top of the Black Creek formation or possibly the Yorktown formation. GPR surveys at a section of the study reach in Greenville oriented east-west, showed a reflective surface that is likely to be the top of the Yorktown formation, or if the Yorktown has been eroded here, the Black Creek or PeeDee formation. GPR surveys at the Port Terminal Road site in Greenville, where the Tar River channel elevation is 1 meter above sea level, suggests that the deepest part of the channel may have incised into a surface that is likely the top of the Yorktown formation.

Recommendations

Given their findings, the investigators recommend that:

- Ground penetrating radar surveys should be run along all major Coastal Plain rivers in North Carolina and correlated with the geology to indicate locations where rivers are in connection with important aquifers and where they are separated by imperme-

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able layers that may retard the exchange of groundwater. Mapping these features could help determine where groundwater management will affect rivers and vice versa. GPR should also be investigated as a subsurface investigation tool for Piedmont and Mountain rivers.

- Given the difference in hydraulic conductivity between the north and south sides of the Tar River and the fact that other Coastal Plain streams may exhibit the same channel asymmetry, research should be undertaken to assess whether the effects of land use and potential for contaminant transport are greater on one side of the river than on the other.
- Holocene and Pleistocene sediments preserved on terraces on the north side of the Tar may hold important information about past climate, hurricane occurrence and flood frequency. Age dating these terraces and Paleo-braidplain deposits along terraces could help unravel the past climate of the region.

In their own future work, the investigators will monitor groundwater at their research sites to help to develop relationships between groundwater flux and specific conductance of groundwater along the Tar. They will also monitor specific conductance during storm events to determine how groundwater fluxes vary during runoff episodes. In addition they will collect more hydraulic conductivity data along the river in temporary wells to better determine the spatial variability of hydraulic conductivity in the river channel sediments and their relationships to groundwater flux and ground penetrating radar data.

- O'Driscoll, Michael A., David J. Mallison, and Patrick K. Johnson. 2008. Surface Water/Ground Water Interactions along the Tar River, NC. Report No. 370 of the Water Resources Research Institute of The University of North Carolina. http://repository.lib.ncsu.edu/dr/bitstream/1840.4/2003/1/NC-WRRI-370.pdf

UNC-Chapel Hill scientists investigate effectiveness of stormwater ponds in removing microbial contaminants

In a project sponsored by the North Carolina Urban Water Consortium through WRRI and by the N.C. Department of Environment and Natural Resources, environmental scientists at UNC-Chapel Hill have enhanced understanding of the effectiveness of wet detention ponds in removing microbial contaminants from stormwater runoff.

Background

Sedimentation-based best management practices (BMPs), such as wet detention ponds, are commonly used to comply with federal NPDES Phase II stormwater rules and total maximum daily load limits for impaired streams. North Carolina guidelines for design of BMPs specify that wet ponds should be capable of retaining runoff from 1 inch of rain for 48 to 120 hours and remove 85% of total suspended solids (TSS) from the stormwater. The Environmental Protection Agency (EPA) has estimated that, through sedimentation, wet ponds also typically remove 65% of bacteria from stormwater. However, previous studies have raised questions about the effectiveness of wet ponds in removing microbial contaminants, one of the most frequent causes of water quality impairment.

In modeling, microbes are generally treated as individual cells of near neutral buoyancy; however, evidence suggests that some portion attach to particles while others remain free and that the microbes in each fraction behave differently. Transport modeling can be improved by quantifying the relative fractions of organisms associated with particles. While previous studies have examined indicator organism partitioning under field conditions and pathogen partitioning under laboratory conditions, in this study, the investigators examined indicator and pathogen partitioning and association in natural waters. Their work focused on where microbial contaminants originate with a watershed, where during their trip from source to stream the microbes attach themselves to particles, how well wet detention ponds remove microbial contaminants, and whether traditional indicator organisms are suitable surrogates for the pathogen Salmonella.

The Study

The investigators conducted their research on an 8.4 mile section of Northeast Creek in Durham, Chatham, and Wake counties that is on the N.C. 303(d) list of impaired streams. Impairment is attributed to elevated fecal coliform concentrations, which raises particular concern because the stream flows into Jordan Lake, a source of drinking water and a recreation site. They established sampling sites at two registered BMPs (wet detention ponds) in residential neighborhoods of the City of Durham and at the receiving stream in the northern part of the watershed and at an additional site downstream in a wooded area adjacent to a waterfowl impoundment. A wastewater treatment plant discharges to the creek between the upstream and downstream sites.

The investigators collected grab samples of street runoff, pond inflow, pond outflow and stream water at upstream and downstream sites under storm and dry weather conditions from June to November 2006. In the laboratory, the investigators analyzed the samples for particle size, total organic carbon, concentrations of three indicator microbes (fecal coliforms, E. coli and enterococci) and Salmonella concentrations. To study the reduction in microbial and particle concentrations throughout a storm, they monitored the inflow and outflow of one wet pond throughout the course of one storm in June 2007.

Findings and Conclusions

Average storm concentrations of indicator organisms were considerably higher at the more developed pond sites than at the in-stream sites, suggesting that the suburban area where the ponds are located—with about 50% impervious surface—are contributing substantially to microbial loading

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to the creek. Storm concentrations of bacterial indicators were nearly two orders of magnitude larger than background, and particle concentrations were about four times background, on average. The particle-attached fraction of each organism studied was found to be roughly constant throughout the transport chain, suggesting that particle-microbe association is initiated at the source. These findings imply that upland developed areas may be good choices for placing sedimentation-based BMPs.

Microbial removal from stormwater by wet ponds was inconsistent, and in many cases concentrations leaving the ponds exceeded those entering the ponds. Mean concentration removals were not significantly correlated with the fractions of microbes defined as "settleable" (attached to particles) in the influent. During storms, on average, concentrations of fecal coliform increased by 13% and Salmonella increased 36% from the inflow to the outflow for Pond 1. Forty-one percent of fecal coliforms and 13% of Salmonella were removed by Pond 2. The design of Pond 2 accomplished a greater detention time than Pond 1, but it still did not achieve the 65% reduction in stormwater microbial loadings cited as "typical" by EPA. During background periods (no rain), average pond outflow concentrations were slightly higher than average inflow concentrations for all indicators and particles in both ponds (except fecal coliforms in Pond 2), suggesting that pond sediments may serve as a source of microbial loadings.

Salmonella were found in surface water samples that meet indicator bacteria criteria for recreational contact. Correlations between fecal indicator bacteria and Salmonella concentrations were relatively strong and statistically significant. These results suggest that concentrations of fecal indicator bacteria and Salmonella are interrelated but that current recreational water quality standards for fecal indicator concentrations do not preclude Salmonella presence at readily detectable levels in 100mL samples. The study also indicates that similar average fractions of Salmonella and fecal indicators are associated with settleable particles, supporting the use of fecal indicator bacteria as surrogates for Salmonella in modeling waterborne transport and settling. However, the ratio of Salmonella to indicators was not found to be constant, which would make prediction of downstream salmonella concentrations and quantification of human health risk difficult.

■ Characklis, Gregory W., Otto D. Simmons III, Mark D. Sobsey, Particia N. Drummey, and Leigh-Anne Krometis. 2008. Identifying the Origins and Attachment Behavior of Non-Point Source Microbial Contaminants. Report No. 384 of the Water Resources Research Institute of The University of North Carolina. http://repository.lib.ncsu.edu/dr/bitstream/1840.4/4114/1/NC-WRRI-384.pdf

Upcoming Events

Erosion and Sedimentation Control Planning and Design Workshop

April 5-6, 2011

NCSU Mountain Horticultrual Crops Research and Extension Center

Mills River (Fletcher), NC

Information and registration at:

http://www.ncsu.edu/wrri/erosionworkshops.html

2011 WRRI Annual Conference & NCWRA Symposium:

March 22-23, 2011
Jane S. McKimmon Center, Raleigh, NC

Exploring Water Resource Needs, Benefits, and Services in North Carolina will be the focus of the 2011 Water Resources Research Institute Annual Conference – North Carolina's premier water research conference. From the opening session on March 22nd to the conclusion with the Progress Energy Water Resources Seminar on March 23rd, key issues, opportunities, and questions about North Carolina's water resources will be addressed with over 40 presentations by university and corporate researchers, students, local, state, and federal government agency representatives, and environmental professionals.

The NC Water Resources Association will again be a key partner in convening the conference, with the NCWRA annual symposium being an integral element of the conference program. The symposium, **"Implementing the Falls Lake Nutrient Management Strategy: Challenges and Opportunities"**, will focus on the implications of one of the most ambitious nutrient management strategies ever advanced by a state. The strategy has far-reaching implications for the management of land and water resources in existing communities, as well as how we develop future communities. The costs could be astounding, but the benefits may include fundamental shifts in how we manage the impacts of our built environments and protect our vital resources.

More information available at:
http://www.ncsu.edu/wrri/conference/index.html